

## **TR-398 Issue 3 WiFi Testing with LANforge: 32 AXE + Mesh**

The TR-398 WiFi Performance test plan by the Broadband forum provides a comprehensive set of tests to qualify the performance of WiFi access points (APs) to be deployed in residential and small office indoor environments. The TR-398 Issue 3 includes new test cases as compared to TR-398 Issue 1 and 2. The new test cases in TR-398 Issue 3 include Latency-under-Load, Quality of Service, Multi-Band throughput, Mesh test cases, 6E support and automated calibration of the testbed. This automation logic allows customization of test execution and pass/fail metrics to allow interested users to run advanced tests not specified in TR398.

The TR398 issue-3 document from Broadband Forum is still in progress. Pass/fail thresholds and perhaps some other small changes to the test procedure are still being resolved.

### **See example reports auto-generated by this testbed:**

- 6.1.1 RX Sensitivity at different angles and encodings.
- 6.2.1 Max Connection 32 station throughput
- 6.2.2 Max TCP Throughput
- 6.2.3 Airtime Fairness
- 6.2.4 Dual Band Throughput
- 6.2.5 TCP Bi-directional Throughput
- 6.2.6 Latency under Load Test
- 6.2.7 Quality of Service
- 6.2.8 Multi-Band Throughput
- 6.3.1 Rate vs Range
- 6.3.2 Spatial Consistency
- 6.3.3 Peak Performance
- 6.4.1 Multiple Stations Performance
- 6.4.2 Multiple Association Stability
- 6.4.3 Downlink MU-MIMO, Requires that AP must be able to disable/enable MU-MIMO.
- 6.4.4 Multicast Multi-Station
- 6.5.1 Long Term Stability.
- 6.5.2 AP Coexistence
- 6.5.3 Automatic channel selection.
- 6.6.1 Mesh Backhaul Rate vs Range
- 6.6.2 2-hop Mesh Backhaul Rate vs Range
- 6.6.3 Mesh Roam

# TR-398 Issue3 Test Report



| Test Setup Information |                    |
|------------------------|--------------------|
| Name                   | CT523c             |
| SIDs                   | 500, 501, 502, 503 |
| Postcards              |                    |
| BSIDs                  |                    |
| Mesh                   | [BLANK]            |
| Estimated Run Time     | 17.5h              |
| Actual Run Time        | 18:01 h            |

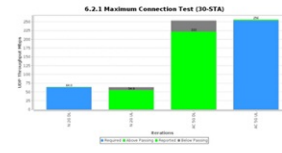
### Objective

The TR-398 Issue 3 WiFi Performance test plan by the Broadband Forum provides a comprehensive set of tests to qualify the performance of Wi-Fi access points (APs) designed for residential and small office environments. Radio performance, throughput, connection stability, antenna fairness, AP Co-existence, MU-MIMO performance, Spatial Consistency and Long-term Stability are all the tests included in this test plan. The test plan is designed for service providers requesting in-home Wi-Fi APs to qualify the APs in their field before deployment and for equipment makers to test during the development of the APs. Candela Technologies offers a fully automated TR-398 Issue 2 test system. The user can select from the list of tests available, upload test cases and equipment models to test during the development of the APs. Results are made and compared to the specified PASS/FAIL criteria in the TR-398 Issue 2 test plan and this report will show the summary PASS/FAIL results followed by more detailed results for each test.

### Summary Results

| Test   | Result | Criteria | Passed | Info   |
|--|--------|----------|--------|--|
| Capability Mesh Setup Antenna Fairness (STA to Node-1) | Pass   | 0        | 0      |  |
| Capability Mesh Setup Antenna Fairness (STA to Node-2) | Pass   | 0        | 0      |  |
| 4.3.1 Receiver Sensitivity Test                        | Pass   | 41       | 2000   | N: 2.4GHz Passed: 21 / 80k Pass Avg: 10.1 N Pass Avg: 13.0<br>N: 5GHz Passed: 18 / 140k Pass Avg: 14.0<br>N: 5GHz Passed: 14 / 17k Pass Avg: 4.2<br>AC 3GHz Failed by tests: 0.0<br>Passed by tests: 48.0<br>Internal ERROR: Resolution table failed to resolve. |
| 4.2.1 Maximum Connection Test (30-STA)                 | Pass   | 95       | 101189 | Throughput N: 2.4GHz is: 86.475 Mbps<br>Throughput AC 3GHz is: 101.026 Mbps  |

| ETA | Test   | Result | Criteria | Passed | Info   |
|-----|--|--------|----------|--------|--|
|     | 4.2.2 Maximum TCP Throughput Test                          | Pass   | 92       | 8367   | Throughput N: 2.4GHz is: 110.176 Mbps<br>Throughput AC 3GHz is: 64.245 Mbps  |
|     | 4.2.3 Airtime Fairness Test                                | Pass   | 0        | 33304  | AC 3GHz Passed: 0 / 4<br>N: 2.4GHz Passed: 3 / 6   |
|     | 4.2.3 Issue 3 Airtime Fairness Test                        | Pass   | 0        |        |  |
|     | 4.4.4 Multiple STA Multicast Test                          | Pass   | 0        |        |  |
|     | 4.2.4 Dual-Band Throughput Test                            | Pass   | 45       | 28312  | N: 7 / 12 AC: 4 / 12   |
|     | 4.2.5 Bidirectional UDP Throughput Test                    | Pass   | 50       | 36463  | N: 2.4GHz Passed: 1 / 3<br>AC 3GHz Passed: 2 / 3   |
|     | 4.2.6 Latency Test   | Pass   | 0        |        |  |
|     | 4.2.7 Quality of Service Test                              | Pass   | 0        |        |  |
|     | 4.3.1 Range Versus Rate Test                               | Pass   | 98       | 21274  | N: 2.4GHz is: 5 / 17 D: 3 / 17<br>AC 3GHz is: 9 / 14 D: 8 / 14   |
|     | 4.3.2 Spatial Consistency Test                             | Pass   | 0        | 58054  | Internal ERROR: Resolution table failed to resolve.<br>N: 2.4GHz Passed: 0 / 0<br>AC 3GHz Passed: 0 / 0<br>AX: 3.6GHz Passed: 0 / 0<br>AX: 4GHz Passed: 0 / 0<br>AX: 4GHz: 140 Passed: 0 / 0 |
|     | 4.3.3 AX Peak Performance TCP Throughput Test              | Pass   | 0        |        |  |
|     | 4.4.1 Multiple STA Performance Test                        | Pass   | 93       | 29817  | N: 2.4GHz Passed: 4 / 6<br>AC 3GHz Passed: 0 / 6   |
|     | 4.4.2 Multiple Association / Disassociation Stability Test | Pass   | 94       | 4750   | N: 2.4GHz Passed: 15 / 14<br>AC 3GHz Passed: 14 / 14   |
|     | 4.4.3 Downlink MU-MIMO Performance Test                    | Pass   | 0        |        |  |
|     | 4.3.2 AP Coexistence Test                                  | Pass   | 156      | 36386  | Passed: 4 / 8<br>NOTE: Auto-Coordinated Interferer Noted in Error:<br>SG: 80MHz AC: 133.33 Mbps<br>SG: 40MHz AC: 14.29 Mbps<br>2.4GHz 20MHz N: 23.40 Mbps                                    |
|     | 4.3.3 Automatic Channel Selection                          | Pass   | 0        |        |  |
|     | 8.1.1 Mesh Backhaul B/W                                    | Pass   | 0        |        |  |
|     | 8.1.2 Mesh Backhaul Node 2 B/W                             | Pass   | 0        |        |  |
|     | 8.1.1 Mesh Mesh Time                                       | Pass   | 0        |        |  |



| Test                                     | Result | Criteria | Passed | Info |
|--|--------|----------|--------|------|
| Max Cx Test: Snapshot N: 2.4GHz Download | Pass   | 0        | 0      |      |

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## Key Measurements

- PASS/FAIL results table for each test per the TR-398 document.
- Detailed per test measurements.

## Overview

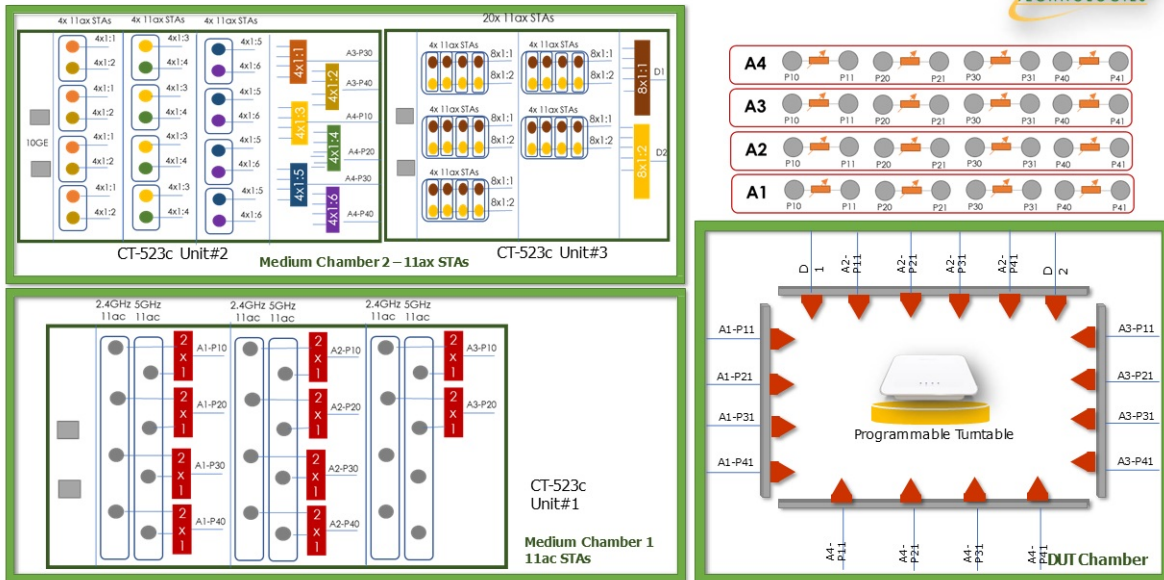
TR-398 Issue 3 Overview Video

Slide presentation for Candela Technologies' TR-398 issue 2 solution.

Candela Technologies offers a fully automated TR-398 Issue 2/3 test system. All the required test hardware including multi station emulator, traffic generator, RF enclosures, turntable, programmable attenuators, and fully automated test software along with PASS/FAIL results are provided in a packaged, easy to use and affordable solution. This testbed uses 32 ax210 tri-band 2.4/5/6E radios for AX test cases, plus 6 dual-band virtual station radios. This offers additional testing opportunities, including AXE testing and 32 station OFDMA tests.

Wiring Diagram for TR398 Issue-3 without Mesh.

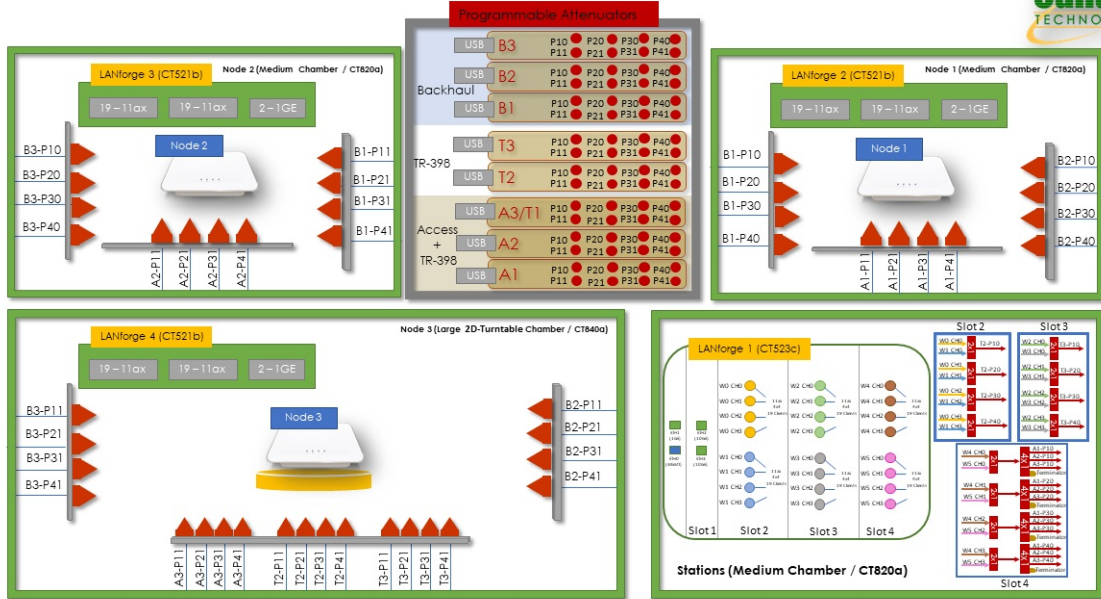
## TR-398 Issue3 Full Testbed Wiring Diagram



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More testbed pictures: CT840b Front CT840b Inside CT840b Front Open CT840b Back

Three Node Mesh + TR-398



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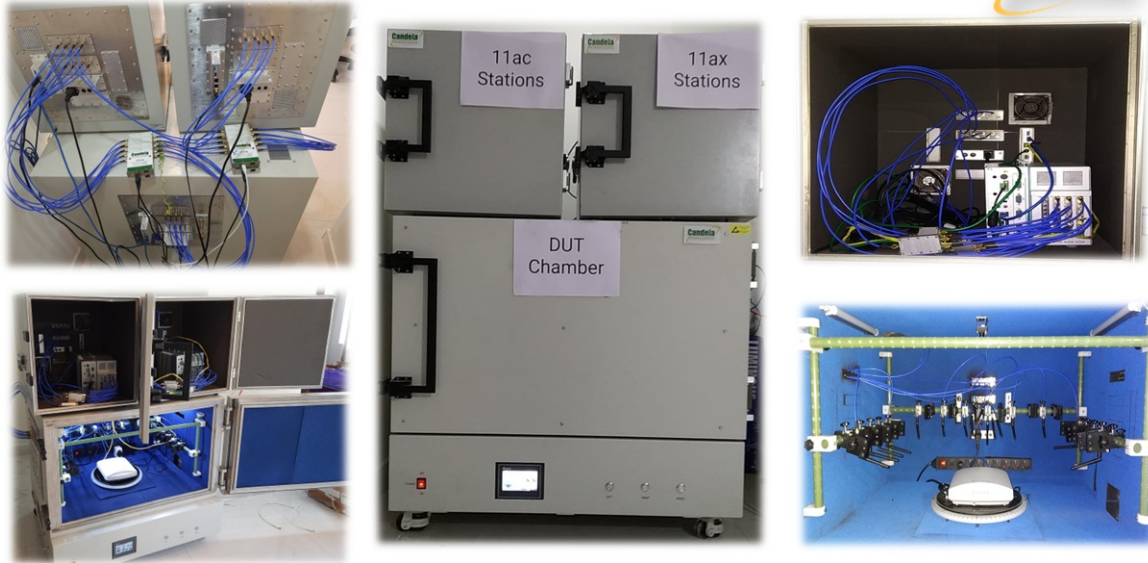
The test setup, testbed components and environment are all created as per the requirements in Section 5 of the TR-398 Issue 3 test plan document. Some of the components may be different than pictured depending on the options purchased. Please ask your sales representative for details.

TR-398 Issue 3+ Mesh Testbed Images



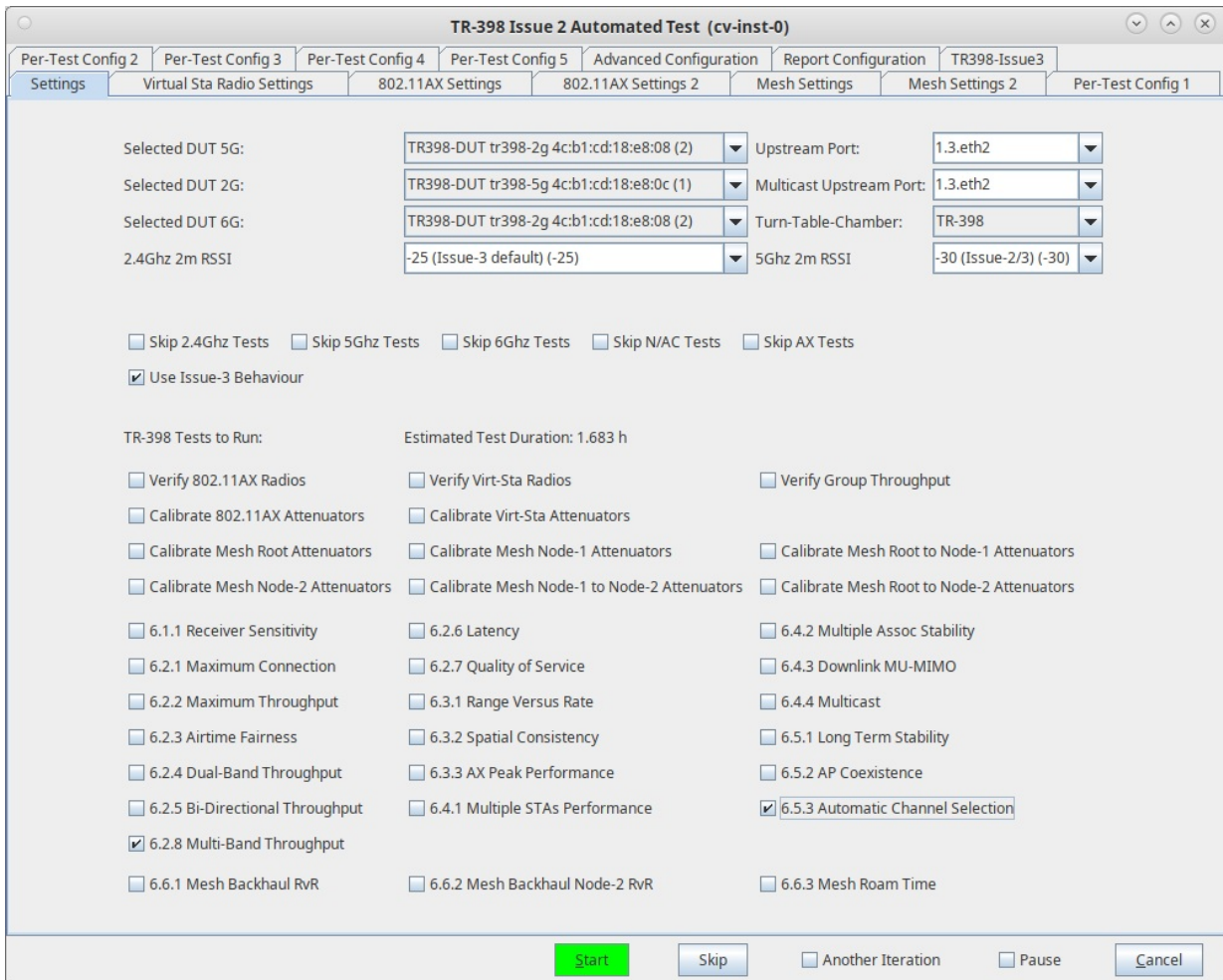
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# TR-398 Issue 3 Testbed Images without Mesh



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The LANforge GUI provides integrated configuration and automation control for all the components of the testbed including the station emulators, traffic generator, attenuators, and turntables. The entire set of supported TR-398 Issue 3 tests, or optionally a subset of these tests, can be run with a single push of a button. An HTML, PDF, and xlsx report can be generated with a second button click when the test completes.



## Includes these Building Blocks

- Hardware
  - LANforge CT523c Multi station Emulation and Traffic Generation Hardware – minimum 6 dual-

- band radios, 32-11ax radios, 6-eth ports (optional 10gE Ports).
- CT521b systems for auto-calibration and for interferer devices needed for some tests.
- CT820a-Medium RF Chambers.
- CT822a-Medium RF Chambers with internal antenna supports.
- CT840a or CT840b Large RF Chamber with Programmable Turntable.
- CT714 4 Port Programmable Attenuators.
- RF Splitters/Combiners.
- Directional Antennas.
- RF Cables.
- **Software**
  - TR-398 Issue 2/3 Automation Software
  - Normal LANforge WiFi testing features are included at no additional charge.

## Key Tests from TR-398 Issue 3 Document

- Calibration and Testbed Setup
  - Automatic calibration of station attenuators.
  - Automatic calibration of mesh backhaul attenuators.
  - Automatic verification of basic testbed correctness.
- 6.1 RF capability
  - 6.1.1 Receiver Sensitivity Test
- 6.2 Baseline performance
  - 6.2.1 Maximum Connection Test
  - 6.2.2 Maximum Throughput Test
  - 6.2.3 Airtime Fairness Test
  - 6.2.4 Dual-band Throughput Test
  - 6.2.5 Bidirectional Throughput Test
  - 6.2.6 Latency under Load Test
  - 6.2.7 Quality of Service Test
  - 6.2.8 Multi-band Throughput Test
- 6.3 Coverage
  - 6.3.1 Range Versus Rate Test
  - 6.3.2 Spatial Consistency Test
  - 6.3.3 802.11ax Peak Performance Test (**4x4 160Mhz and higher not supported at this time**)
- 6.4 Multiple Stations Performance
  - 6.4.1 Multiple Stations Performance Test.
  - 6.4.2 Multiple Association/Disassociation Stability Test.
  - 6.4.3 Downlink MU-MIMO Performance Test (**6E not currently supported, not required by TR398i3**).
  - 6.4.4 Multicast Performance Test (not officially part of TR398 Issue3).
- 6.5 Stability/Robustness
  - 6.5.1 Long Term Stability Test
  - 6.5.2 AP Coexistence Test (**6E not currently supported.**)
  - 6.5.3 Automatic Channel Selection Test (**6E not supported at this time**)
- 6.6 Mesh test cases (TR398 issue-3)
  - 6.6.1 Mesh Backhaul Rate vs Range

- 6.6.2 2-hop Mesh Backhaul Rate vs Range
- 6.6.3 Mesh Roaming Test
- 7 AP Stability/Robustness
  - 7.1.1 RSSI Accuracy (**Not supported at this time**)
  - 7.1.2 Channel Utilization Accuracy (**Not supported at this time**)
  - 7.1.3 Noise Accuracy (**Not supported at this time**)

Many of the features not currently supported by the automation can be executed manually.

## Lead Times and Support:

**i** Please contact [support@candelatech.com](mailto:support@candelatech.com) if you need any assistance.

**Lead Times:** Four to six weeks.

**TaaS/Onsite Support:** Customers with only occasional test needs can use our Test as a Service option. Candela engineers can do the testing for you in our fully equipped test lab and provide a detailed test report with recommendations.

For more information, please contact [sales@candelatech.com](mailto:sales@candelatech.com) or give us a call at: 1-360-380-1618

Candela Technologies, Inc., 2417 Main Street, Suite 201, Ferndale, WA 98248, USA  
[www.candelatech.com](http://www.candelatech.com) | [sales@candelatech.com](mailto:sales@candelatech.com) | +1.360.380.1618